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(54) Abstract Title
Method of preparing a security document having an unpigmented polyurethane coating

(57) A method of preparing a security document which comprises printing on security paper and thereafter applying a transparent coating composition comprising an unpigmented polyurethane, said coating composition being such as to provide a film, when cast on a glass surface, that has a König hardness of from 15 to 130 seconds, and also passes the water resistance test as defined by the following steps:

(a) the total formulation to be used in the coating is cast on a glass plate so as to produce a film with a dry weight of 80 g/m^2;

(b) the film is initially dried at 23 °C and once tack free dried for an additional hour at 80 °C;

(c) the film is weighed before being wetted and tested for tensile strength and Young's Modulus and is visually checked for any change in transparency;

(d) a sample of the film is boiled in water containing 10 g/litre Na_2CO_3 for 30 minutes;

(e) the film is then rinsed in cold water and the steps (b) to (c) are then repeated;

wherein when the film is dried and re-weighed the film meets the following criteria:

(i) the wet tensile strength and Young's Modulus of the boiled film are not less that 90% of the initial film wet tensile strength and Young's Modulus;

(ii) the film shows no perceptible loss of transparency; and

(iii) the dried weight of the film is not less than 98% of the original weight.

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Method of Preparing a Security Document

The present invention relates to a method for preparing a security document, and more particularly to those documents which are subject to considerable amounts of handling such as banknotes and driving licences.

It is important that such security documents should be durable; in other words they should be resistant to tearing, fold damage and soiling. Moisture and chemicals absorbed by such security documents during handling can lead to physical degradation. It is desirable that the substrate for such security documents is resistant to absorption. It is, of course, a prime requirement for such security documents that the print which is applied to the substrate should adhere well, especially under severe conditions involving mechanical abrasion or accidental laundering.

Security documents of the kind with which this invention is concerned incorporate one or more security features, especially visible security features, to prevent or deter counterfeiting. Such security features which may be used include, for example, watermarks and security threads present in the paper. Security threads may be disposed entirely within the paper or may appear in so-called windows located between regions where the thread is positioned between the surfaces of the paper for example as present in the Bank of England Series E banknotes. It is normal in security documents for the substrate to be of sufficiently good quality such as to enable satisfactory embossing to be achieved, such as embossing produced by the known Intaglio printing and

to ensure good wear properties.

Previous proposals to provide paper for security documents which have good soil resistance and durability have involved the use of coating compositions which incorporate a pigment together with a binder such as an elastomeric binder. It is also known generally that various polyurethane compositions can be used on a wide variety of substrates to provide coatings which have a protective effect of one kind or another; amongst such uses, polyurethanes have been employed as a varnish for wood or other substrates. Also, it is known from European Patent EP-B-189945 to use polyurethane compositions as sizings for paper.

In the case where a coating composition involving a pigment is used for the production of security paper, e.g. as in WO-A-91/12372, such pigment usually has a benefit in providing microporosity or roughness which enables satisfactory ink keying to be achieved. However, there is a serious disadvantage resulting from the presence of a pigment, namely that a security feature such as a watermark or windowed thread present in the substrate is to some extent obscured.

Pigmented coatings are inherently weak resulting from the presence of the pigment which causes the binder to be less firmly attached to the substrate in specific locations.

EP-A-813,321 describes a method of preparing a security document in which a substantially transparent coating composition comprising an unpigmented polyurethane which meets certain requirements is applied after a sizing agent on paper to prepare a security paper. This security paper may be printed on to form a security document. Such a method produces

security paper which has performed well in the market. It is possible to further improve the soil resistance of the paper by having a thicker coating. However, it has been found that the thicker the coating, the more problems there are with ink adhesion of the printing on top of the coating. In particular the adhesion becomes poorer after the security document has been in circulation for some time, particularly with relatively thick printing such as Intaglio printing. Furthermore, it has been found that increasing the thickness of the coating under the printing can lengthen the drying time of the printing. For example, we have found that wet litho printing can take 6 days to dry on normal paper, but 9 days on coated paper. Paper with thicker coatings tends to have longer drying times.

It is known to coat security papers with a varnish after printing. However, such varnishes tend to crack over time and soil and dirt can accumulate in the cracks.

We have surprisingly found that providing the coating over the printing provides similar soil resistance and reduces or overcomes the problem of lack of adhesion of the printing. Furthermore, surprisingly this coating does not appreciably crack like some known varnishes and so does not substantially suffer from soil and dirt accumulation in these areas. Additionally, coating over the printing can avoid lengthy drying times.

Accordingly the present invention provides a method of preparing a security document which comprises printing on at least one side of a security paper and thereafter applying to at least one side of the printed security paper over the printing a

substantially transparent coating composition comprising an unpigmented polyurethane, said coating composition being such as to provide a film, when cast on a glass surface, that has a König hardness of from 15 to 130 seconds, and also passes the water resistance test as defined by the following steps:

(a) the total formulation to be used in the coating is cast on a glass plate so as to produce a film with a dry weight of 80 g/m^2;

(b) the film is initially dried at 23 °C and once tack free dried for an additional hour at 80 °C;

(c) the film is weighed before being wetted and tested for tensile strength and Young's Modulus and is visually checked for any change in transparency;

(d) a sample of the film is boiled in water containing 10 g/litre Na_2CO_3 for 30 minutes;

(e) the film is then rinsed in cold water and the steps (b) to (c) are then repeated;

wherein when the film is dried and re-weighed the film meets the following criteria:

(i) the wet tensile strength and Young's Modulus of the boiled film are not less that 90% of the initial film wet tensile strength and Young's Modulus;

(ii) the film shows no perceptible loss of transparency; and

(iii) the dried weight of the film is not less than 98% of the original weight.

The present invention also provides a security document comprising a security paper having printing on at least one side thereof and a coating composition as defined above applied over said printing.

The coating used in the present invention is the same

as defined in EP-A-815,321 which is herein incorporated by reference. Thus the aqueous polyurethane may be in the form of an aqueous dispersion, for example having a polyurethane content of 2 to 70 wt.%, especially 5 to 40 wt.%, more especially 5 to 30 wt.% with respect to the total weight of the dispersion. The coating may incorporate an extender such as a polyacrylate and hence be in the form of a urethane-acrylic blend; such a blend provides good water and chemical resistant coatings. Also, the low cost of an extender relative to that of the polyurethane results in the blend being considerably less costly than the polyurethane alone.

The coating may be a polyurethane dispersion with a one component pre-crosslinked polyurethane or with a one component, blocked polyurethane which has isocyanate groups chemically bound to the polymer chains but which isocyanate groups are regenerated at those elevated temperatures which are generally used in the final stages of a security printing process, for example using heat from the printer driers. Furthermore, the coating may be a polyurethane dispersion of a two-component product which can be crosslinked by using multi-functional reagents such as melamine/formaldehyde precondensate. Crosslinking agents which may be used are described later. The polyurethane may be, for example of the aliphatic polyester or aliphatic polyether type. It may also, for example, be an aliphatic polycarbonate polyurethane.

A polyurethane composition for use in the method of this invention may include ingredients known to those skilled in the art such as catalysts, cosolvents and emulsifying agents and/or surfactants. Care has to be taken, however, because an emulsifying agent can

detract from the performance of the coating under wet or humid conditions. Additionally, other known additives may be used such as defoamants, flow additives, thickeners and/or viscosity modifiers. In general an additive included in the coating composition should be kept to a minimum as important properties such as adhesion to the substrate may be adversely affected.

Whilst the main aspect of the present invention is the provision of beneficial unpigmented coatings in order to provide the advantages described herein, in one aspect of the invention various functional additives may be used in order to provide specific effects which enhance the security of a security document produced from the paper of this invention without significantly interfering with the general benefits provided by the unpigmented polyurethane coating. It will be understood by those skilled in the art that pigments are added to coatings, especially to paper coatings to provide colour or opacity. The functional security additives which may be used in accordance with this invention are particulate materials which satisfy the following criteria:

a) the additive does not increase the opacity of the paper, once the coating is applied, by more than 1%. This ensures that the additive has no appreciable effect on the transparency of the coating and hence the general benefits of unpigmented coatings are retained;

b) the presence of the additive in the polyurethane coating does not cause failure of the tests which identify the polyurethane coating for this invention, namely the König hardness test and the water-resistance test.

The functional additive is preferably a fluorescent or

iridescent pigment.

A security functional additive will provide some specific effect to enhance the security or recognisability of a security document produced in accordance with this invention and hence constitutes an additional security feature when such additive is present in the polyurethane coating. In general, security functional additives fall into three classes:

(a) publicly recognisable security features such as iridescent pigments;

(b) security features which provide higher levels of security and which are detectable with security equipment, such as fluorescent pigment, or magnetic particles; and

(c) covert security features detectable by use of sophisticated detecting equipment such as may be used by central banks, e.g. phosphorescent pigments which possess unique decay times.

In order to achieve the prime requirements of this invention, the coating comprising the polyurethane must be substantially transparent as explained herein, and preferably have a 100% modulus of greater than 4.0 mPa. It is desirable that the polyurethane coating has an ultimate tensile strength of greater than 40 mPa, for example from 40 to 80 mPa, as well as having a König hardness of greater than 20 seconds, for example from 20 to 40 seconds.

Extenders can be used in the formulation of the coating in order to reduce the cost; they may also impart useful properties such as improved adhesion of surface applied security features, such as holograms.

Extenders which may be used in accordance with this invention are typically dispersions of water insoluble

binders such as styrene/acrylic copolymers, acrylated vinyl acetate, vinyl chloride/ethylene copolymers, or vinyl acetate copolymers. They are generally unable to withstand both the water-resistance and hardness tests. An alternative extender is a VA/VEOVA copolymer, for example that sold under the trade name Vinamul™ 6975.

However, in combination with a suitably polyurethane the extenders function satisfactorily in terms of the criteria previously set out, provided that the composition comprising the polyurethane and the extender possess the specified König Hardness and pass the water-resistance test.

The extenders may be added at levels up to 70, preferably from 15 to 50, parts per 100 parts of the coating formulation. The strongest and most water-resistant extenders can be added at this level. Weaker and less water-resistant extenders clearly cannot be added at such high levels bearing in mind the properties specified for the coating composition.

Crosslinking agents can be used to increase the water-resistance, including laundry resistance, and hardness of the polyurethane coating. They can be used to obtain the required properties from polyurethanes which would otherwise be unsuitable. They can also improve the properties of the polyurethane component thereby enabling greater quantities of extender to be used. Suitable crosslinking agents include polyaziridine, carbodiimide, isocyanate and zirconium salts. Other crosslinkers such as an epoxy resin may be used but are less practical due to their high cure temperatures or longer cure times.

The coat weight of the coating applied over the

printing is, for example, from 0.05 to 20g per square metre, preferably 0.5 to 10g per square metre, more preferably 1 to 7g per square metre and especially 2 to 6g per square metre. It is also possible for the security paper to be coated with a coating composition before it is printed. Any coating composition may be used, although desirably a coating composition meeting the same requirements as the coating composition defined above applied over the printing is used. In this case the coating composition applied under the printing may be the same or different as the coating composition applied over the printing. The coat weight of the coating composition applied under the printing is generally from 0.5 to 5g per square metre, preferably 1 to 2.5g per square metre. If more than one coating composition is applied, the total coat weight of the coating compositions applied before and after the printing is preferably 0.05 to 20g per square metre, more preferably from 0.5 to 10g per square metre, even more preferably from 3 to 10g per square metre, most preferably from 3 to 7g per square metre, especially 4 to 5g per square metre. We have found that there may be an advantage in using two coats rather than one coat since this leads to less coating defects.

It is possible for further printing to be applied over the coating applied above the initial printing. Such further printing may, for example, be part of the design of the security document or may simply be a unique identifier for a particular security document, such as a number.

The printing on the security document may be any type of printing, for example litho or intaglio or a combination thereof. The coating may be applied at any time after the first printing, but preferably

after substantially all of the printing except optionally for minor additional printing such as unique identifiers. It has surprisingly been found that the coatings used in the present invention can be used over intaglio printing even though the intaglio printing has a thickness which is typically 40 μm but which can be significantly greater, e.g. about 85 μm, creating large peaks and valleys on the printed paper.

The method of the present invention can be used by a single security document manufacturer on paper provided by different paper manufacturers. There may also be a cost saving since it is only the final security document which needs to be coated and not large paper rolls, some of which paper may be wasted.

The security paper may be prepared by any known method such as the method described in EP-A-815,321. Thus paper-making fibres may be supplied to a paper-machine, at least one security feature incorporated into the paper during its manufacture to produce the paper, and a sizing agent applied to the resulting paper to size the paper. Suitable security features are, for example, a watermark and/or an embedded thread or windowed thread which may itself optionally incorporate visual or a coverture security elements.

The present invention is now further described in the following Example.

Example

A soiling test was carried out to demonstrate the advantages of the present invention.

The soiling test was based on the test defined in British Standard BS 4948/;1973 "Method for assessment

of the visible soiling of upholstery fabrics", but with the following changes:

1. The soil test media consisted of the felt cubes impregnated with a composition comprising:
   - 10 g coconut oil
   - 10 g cotton seed oil
   - 12 g groundnut oil
   - 4 g lauric acid
   - 14 g myristic acid
   - 41 g palmitic acid
   - 13 g stearic acid
   - 18 g oleic acid
   - 20 g cholesterol
   - 40 g liquid paraffin
   - 10 cm^3 DAG colloidal graphite dispersion;

2. The grey scale assessment test was replaced by lightness measurements L* on a Labscan II machine with the following conditions:
   - D65 illuminant
   - 10° observer
   - 50 mm port
   - 44 mm area of view
   - no UV component
   - black tile used as backing

   The position and orientation of the samples was the same before and after the soil test in order to reduce any errors;

3. Ambient conditions were used, and the temperature and humidity were not controlled;

4. The sample size was cut to fit the chamber. Typically the sample was 67mm square or a circle

cut to the chamber diameter;

5. For the felt cubes, a new batch was standardised against the old batch to ensure a similar degree of soiling;

6. 20 cubes were used rather than 40;

7. The tests were carried out for 30 minutes rather than from 90 minutes to 3 hours; and

8. The cubes were changed when they showed signs of wear, rather than being specifically monitored for their soling performance, so long as the change in L* was greater than 10 on unprinted control paper.

A paper coating composition was prepared by adding the following components to water to provide a composition containing about 35% solids:

Witcobond WB785	40kg
CX 100 Cross Linker	150g
Antifoam	40g

The composition was then diluted before use to a suitable coating viscosity and to achieve the coat weights defined below.

Four samples of paper were tested. The first was uncoated paper having printing thereon to act as a comparison. The second had the above coating under the printing at a coat weight of 2.5 g/m^2. The third and fourth were in accordance with the present invention. The third sample consisted of the same printed paper but with a coating only over the printing in accordance with the present invention.

This coating had a coat weight of 2.5 g/m². The fourth sample also consisted of the same printed paper but with the same coating being applied both under the printing at a coat weight of 2 g/m² and over the printing in a coat weight of 2.5 g/m².

The soil index was calculated for a number of different paper samples using lightness measurements obtained from this test and the following formula:

$$SoilIndex = \frac{\Delta L^*_{Control} - \Delta L^*_{Test}}{\Delta L^*_{Control}} \times 100\%$$

The following results were obtained:

Uncoated paper:	0%
Paper with coating under printing:	30%
Paper with coating over printing:	36%
Paper with coating under and over printing:	50%

This clearly shows that the coating method of the present invention provides paper having less susceptibility to soiling.

CLAIMS

1. A method of preparing a security document which comprises printing on at least one side of a security paper and thereafter applying to at least one side of the printed security paper over the printing a substantially transparent coating composition comprising an unpigmented polyurethane, said coating composition being such as to provide a film, when cast on a glass surface, that has a König hardness of from 15 to 130 seconds, and also passes the water resistance test as defined by the following steps:

(a) the total formulation to be used in the coating is cast on a glass plate so as to produce a film with a dry weight of 80 g/m^2;

(b) the film is initially dried at 23 °C and once tack free dried for an additional hour at 80 °C;

(c) the film is weighed before being wetted and tested for tensile strength and Young's Modulus and is visually checked for any change in transparency;

(d) a sample of the film is boiled in water containing 10 g/litre Na_2CO_3 for 30 minutes;

(e) the film is then rinsed in cold water and the steps (b) to (c) are then repeated;

wherein when the film is dried and re-weighed the film meets the following criteria:

(i) the wet tensile strength and Young's Modulus of the boiled film are not less that 90% of the initial film wet tensile strength and Young's Modulus;

(ii) the film shows no perceptible loss of transparency; and

(iii) the dried weight of the film is not less than 98% of the original weight.

2. A method according to claim 1 wherein the polyurethane is in the form of an aqueous dispersion.

3. A method according to claim 2 wherein the dispersion has a polyurethane content of 5 to 40 wt% with respect to the total weight of the dispersion.

4. A method according to any one of the preceding claims wherein the coating composition also comprises an extender.

5. A method according to claim 4 wherein the extender is a dispersion of a water-insoluble styrene/acrylic copolymer, acrylated vinyl acetate, vinyl chloride/ethylene copolymer or vinyl acetate copolymer, or a VA/VEOVA copolymer.

6. A method according to any one of the preceding claims wherein the polyurethane is of the aliphatic polyester type.

7. A method according to any one of the preceding claims wherein the polyurethane is of the aliphatic polyether type.

8. A method according to any one of the preceding claims wherein the polyurethane is crosslinkable and is crosslinked after being applied.

9. A method according to claim 8 wherein the crosslinking is effected using an aziridine as a crosslinking agent.

10. A method according to any one of the preceding claims wherein the polyurethane composition also comprises a functional additive which is a fluorescent or iridescent additive.

11. A method according to any one of the preceding claims wherein the security paper comprises a security feature which is a watermark, an embedded thread and/or a windowed thread.

12. A method according to any one of the preceding claims wherein the coat weight of the coating is from 0.05 to 20g per square metre.

13. A method according to claim 12 wherein the coat weight is 1 to 7g per square metre.

14. A method according to any one of the preceding claims wherein the security paper is also coated with a coating composition before it is printed.

15. A method according to claim 14 wherein the coating composition applied before the printing is as defined in claim 1.

16. A method according to claim 14 or 15 wherein the coat weight of the coating composition applied before the printing is from 0.5 to 5g per square metre.

17. A method according to claim 16 wherein the coat weight is from 1 to 2.5g per square metre.

18. A method according to any one of claims 14 to 17 wherein the total coat weight of the coating compositions applied before and after the printing is from 3 to 7g per square metre.

19. A method according to any one of the preceding claims wherein further printing is applied to the security document over the coating.

20. A method according to any one of the preceding

claims wherein the security document is a banknote.

21. A security document comprising a security paper having printing on at least one side thereof and a coating composition as defined in claim 1 applied over said printing.

Application No:	GB 0203916.2	**Examiner:**	Richard Pannett
Claims searched:	1-21	**Date of search:**	8 November 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B6A (ATC)

Int Cl (Ed.7): B42D, D21H, G07D

Other: Online: EPODOC, JAPIO, WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	WO 93/13942 A1	(BOSISIO) See: abstract; page 2 lines 2-12; claim 4; figures 1-4.	
A	US 6224958 B1	(MAHN) See: abstract; column 1 line 60 to column 2 line 8; column 3 lines 3-45; figures 1-3.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.